Magnetic Activity in FK Com

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Abstract. Surface (Doppler) imaging techniques have earlier been used to study the spot configuration and evolution over a three year period in a single, late-type star, FK Com. In the present work we investigate photometric observations of FK Com obtained since 1966. These observations enable us to study the spot configuration on the stellar surface over much longer time period than the surface imaging alone permits. Together these two different types of measurements give us a unique chance to study the possible permanent active longitudes and the flipping of the activity between these two longitudes.

1. Introduction

FK Com (HD117555) is the prototype of the small group of rapidly rotating single G-K giants, the FK Com-type stars (Bopp & Stencil 1981). FK Com itself is classified as a single G5 II-G8 III giant with a vsin i of 162.5 ± 3.5 kms⁻¹ (Huenemoerder et al. 1993). Small variations in the visual magnitude of FK Com of 0.01 with a period of 2.412 were first reported by Chugainov (1966). These variations were later interpreted to be caused by asymmetrically distributed spots (Bopp & Rucinski 1981). Jetsu et al. (1993) determined a photometric period of 2.4002466 ±0.0000056 from 25 years of photometric observations and discovered a switch of activity between two active longitudes 180 degrees apart (“flip-flop”). A summary of all available photometry up to 1996 was presented by Strassmeier et al. 1997.

The first surface map of FK Com was obtained by Piskunov et al. (1994). Their results for the year 1989 show low-contrast cool photospheric spots near the equator and some high latitude He I D3 emission. The next surface maps of FK Com were obtained for the years 1994–1997 (Korhonen et al. 1999, Korhonen et al. 2000). These maps mainly show high latitude spots and no clear polar spots. These maps were also used for studying possible surface differential rotation. No evidence for it could be found from temperature maps separated by 30 days, 72 days and about a year (Korhonen et al. 2000).

2. Photometric observations of FK Com

We have analysed all the available photometric observations of FK Com. The observations have been published in Jetsu et al. (1994a, 1994b), Strassmeier et
Figure 1. All the V band observations of FK Com (left) and the maximum, mean and minimum V magnitudes from each observing period (right). The difference between the maximum and minimum magnitude has been exaggerated by 0\textsuperscript{m}2 (in the figure on the right).

Figure 2. An example of the light curve inversions. These maps also show a clear “flip-flop”.

al. (1997) and Korhonen et al. (2001). All the V observations are plotted with the Julian date in Figure 1 together with the maximum, mean and minimum V magnitudes for each observing period. The period analysis of maximum, mean and minimum magnitudes showed two dominant types of periods: long periods about 14 and 32 years (in the mean and maximum) and short periods about 3 and 6 years (in the mean and minimum). The period analysis was also done for the peak-to-peak variation of the V amplitude which only showed short periods with dominant period ~ 6 years. The longest period (~ 30 yr) seem to correspond to the period of the total minimum-maximum variation from the 1970's to the 1990's and the shortest periods correspond to the “flip-flops” (Korhonen et al. 1999).

3. Light curve inversions

The individual light curves have been inverted to investigate the spot position and evolution during the 35 years of photometric observations of FK Com. An example of the results from the light curve inversions is shown in Figure 2. This plot also shows an example of the “flip-flop” phenomenon.
Figure 3. The spot position for the years 1984–1997 measured from the light-curve inversions plotted against the Julian Date. Closed circles represent the main spot of that time and open circles possible secondary spots. Dotted vertical lines are the times of the “flip-flops”.

In total, 48 maps of the spot configuration were obtained using light-curve inversions. The phases of the spots were measured and plotted against the Julian Date (Figure 3), both primary and secondary spots were plotted. As can be seen the spot activity in FK Com is concentrated mainly on two active longitudes, which migrate in time. In the migration two different rates can be seen, corresponding to rotational periods: \(2^{d}.40036 \pm 0^{d}.00013\) and \(2^{d}.4030 \pm 0^{d}.0003\). The first rate coincides within the error with the long-term average (Jetsu et al. 1993), while the second rate was previously detected in the surface images for 1994–1997 (Korhonen et al. 2000). The “flip-flops” occur between these two active longitudes with an average period of about 3 years. The photometric observations before 1984 are so sparse that detecting the active longitudes is difficult and, on the other hand, the results for 1998 and later need to be checked with our surface images for that time.

4. Conclusions

From the analysis of the 35 years of photometric observations of FK Com we obtain the following results:

- The period analysis of maximum, mean and minimum V magnitudes exhibit two dominant types of periods: long periods around 14 and 32 years
and short periods around 3 and 6 years. The 3 and 6 year periods correspond to the “flip-flops”

- The spot activity in FK Com occurs at two active longitudes which migrate in time. Two migration rates can be seen corresponding to spot rotational periods of $\sim 2^{d}4002$ and $\sim 2^{d}4030$.

- In the “flip-flops” the dominant part of the spot activity changes the active longitude. The period for this change is $\sim 3$ years.

Acknowledgments. The work of HK was supported by the Finnish graduate school in Astronomy and Space Physics and Vilho, Yrjö and Kalle Väisälä Foundation.

References